Preface

Long-memory, or more generally fractal, processes are known to play an important role in many scientific disciplines and applied fields such as physics, geophysics, hydrology, economics, finance, climatology, environmental sciences, biology, medicine, telecommunications, network engineering, to name a few. There are several reasons for the ubiquitous occurrence of processes in the realm of long memory. First of all, hyperbolic scaling occurs naturally (up to modifications by slowly varying functions) in limit theorems for partial sums, since, under very general conditions, the limiting processes are necessarily self-similar. One may in fact say that in the world of stochastic processes, self-similar processes play the same fundamental role as stable distributions (including the normal) in the world of finite-dimensional distributions. Hyperbolic scaling phenomena are also an essential ingredient in statistical physics (a related notion is, for example, the so-called renormalization group). This is, at least partially, connected with the role of self-similar processes in limit theorems. Another reason for the occurrence of long-memory phenomena is aggregation. This, together with heterogeneity, is a frequent explanation of long-range dependence in an economic context. In telecommunications and computer networks, distributional properties of waiting times can lead to similar results. Finally, there is also a connection to fractals (though not always direct, depending on more specific distributional assumptions).

Although the notion of long memory and related topics can be traced far back into the early 20th or even the late 19th century, it is probably fair to say that the subject has been brought to the attention of a wider mathematical audience (and, in particular, probabilists and statisticians) by the pioneering work of Mandelbrot and his coworkers. A similar pathbreaking role can be attributed to Granger in economics, to Dobrushin (and before, to Kolmogorov) in physics and, even earlier, to Hurst in hydrology. These early contributions motivated a number of eminent probabilists to develop a theory of stochastic processes in the realm of stochastic self-similarity, scaling laws and nonstandard limit theorems. The development of statistical methods followed. An overview of the state of the art in the early 1990s can be found, for instance, in Beran (1994a). Other books and monographs on the topic, most of them with a special focus on certain areas of application or specific methods or processes, are, for instance, Park and Willinger (2000), Dehling et al. (2002), Embrechts and Maejima (2002), Robinson (2002), Doukhan et al. (2003), Rangarajan and Ding (2003), Teyssière and Kirman (2005), Bertail et al. (2006), Samorodnitsky (2006), Palma (2007) and Giraitis et al. (2012).

Since the appearance of the first monograph on statistical methods for long-memory processes in the early 1990s, there has been an enormous development. One now has a much better understanding of the probabilistic foundations and statistical principles, various new techniques have been introduced to derive limit theorems and other fundamental results, and a large variety of flexible statistical methods are now available, including parametric, nonparametric, semiparametric and adaptive inference for stationary, nonstationary, locally stationary and nonlinear processes. This book grew out of the need to summarize the main results in this rapidly expanding area. Due to the progress in the last two decades, a more systematic account of theory and methods can be given. The aim is to cover both, probabilistic and statistical aspects, in as much detail as possible (given a limited number of pages), while at the same time including a broad range of topics. Because of the enormous number of theoretical and an even more overwhelming quantity of applied papers in this area, it was not possible to include all interesting results, and we apologize in advance to all authors whose contributions we could not mention. Apart from the mathematical theory, practical aspects of data analysis are discussed and illustrated by examples from various fields of application. We hope that this book will be useful to researchers interested in mathematical aspects of long-memory processes as well as to readers whose focus is on practical data analysis.

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